US006545854B2

(12) **United States Patent**
Trinh et al.

(10) **Patent No.: US 6,545,854 B2**
(45) **Date of Patent: Apr. 8, 2003**

(54) **FRINGE-FIELD NON-OVERLAPPING-ELECTRODES DISCOIDAL FEED-THROUGH CERAMIC FILTER CAPACITOR WITH HIGH BREAKDOWN VOLTAGE**

(75) Inventors: **Hung Trinh**, San Diego, CA (US); **Daniel F. Devoe**, San Diego, CA (US)

(73) Assignee: **Presidio Components, Inc.**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/865,816**

(22) Filed: **May 25, 2001**

(65) **Prior Publication Data**

US 2002/0175782 A1 Nov. 28, 2002

(51) **Int. Cl.**[7] .......................... **H01G 4/35**; H01G 4/005
(52) **U.S. Cl.** ....................................... **361/302**; 361/303
(58) **Field of Search** .......................... 361/301.1–301.4, 361/302–305, 306.1–306.3, 307, 308.1, 309, 311, 312, 320, 321.1–321.5, 328–330

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,148,003 A 4/1979 Colburn et al.
4,247,881 A 1/1981 Coleman
5,177,663 A * 1/1993 Ingleson et al. ......... 361/321.2
5,333,095 A 7/1994 Stevenson et al.
5,751,539 A 5/1998 Stevenson et al.
5,822,174 A 10/1998 Yamate et al.
5,825,608 A 10/1998 Duva et al.
5,870,272 A 2/1999 Seifried et al.
5,905,627 A 5/1999 Brendel et al.
5,926,357 A 7/1999 Elias et al.
5,959,829 A 9/1999 Stevenson et al.
5,973,906 A 10/1999 Stevenson et al.
5,999,398 A 12/1999 Makl et al.
6,008,980 A 12/1999 Stevenson et al.
6,018,448 A 1/2000 Anthony
6,191,931 B1 2/2001 Paspa et al.
6,208,501 B1 3/2001 Ingalls et al.
6,414,835 B1 * 7/2002 Wolf et al. ................ 361/302

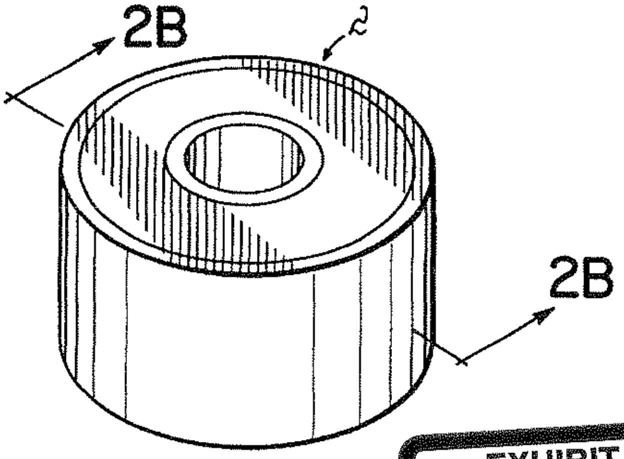
* cited by examiner

*Primary Examiner*—Chau N. Nguyen
*Assistant Examiner*—Eric Thomas
(74) *Attorney, Agent, or Firm*—Wood, Herron & Evans, L.L.P.

(57) **ABSTRACT**

The size and placement of internal metallization areas as do collectively form each of two electrodes is improved in a typically discoidal feed-through ceramic filter capacitor having (i) multiple ceramic layers, (ii) a hole passing a wire that carries electrical signals which are to be filtered, (iii) metal lining the hole so as to make electrical contact with the wire, and (iv) an exterior metal band connected to ground. First internal metallization areas, each in the shape of a relatively smaller small-aperture disk, are centered about the body's hole in contact with the metal lining, each area being upon one of the body's multiple ceramic layers, the areas collectively serving as a first electrode of the capacitor. Second internal metallization areas, each in the shape of a relatively larger large-apertured disk also centered about the hole and upon one of the ceramic layers, make at their exterior edge surface electrical contact with the metal band, thereby to serve as a second electrode of the capacitor. The respective metallization areas of each electrode are both (i) spaced far apart by previous standards, and, preferably, (ii) are located upon alternating ceramic layers, making that any voltage breakdown path is necessarily both (i) long and with (ii) both radial and longitudinal components. According to this long path, the breakdown voltage is high, typically 3000–4000 volts, making the capacitor suitable for, inter alia, implanted cardiac defibrillators.

**35 Claims, 2 Drawing Sheets**



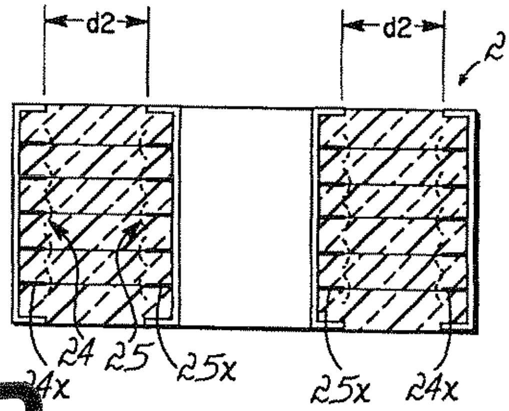


EXHIBIT
Ex 5
Ewell 8-1-08

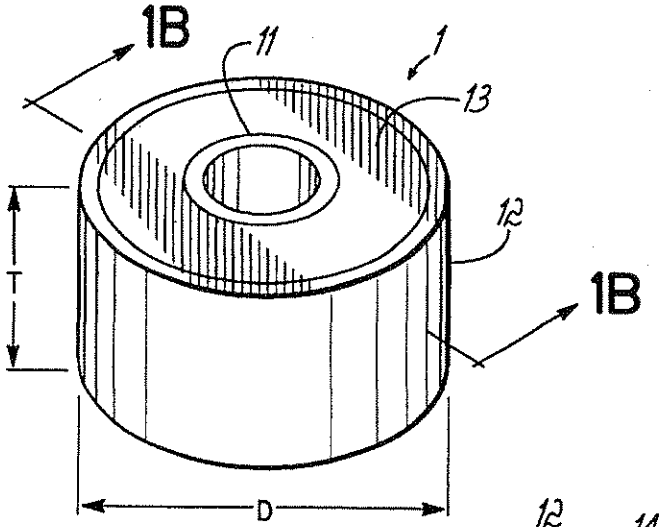

1B
11
1
13
12
T
1B
D

FIG. 1A
PRIOR ART

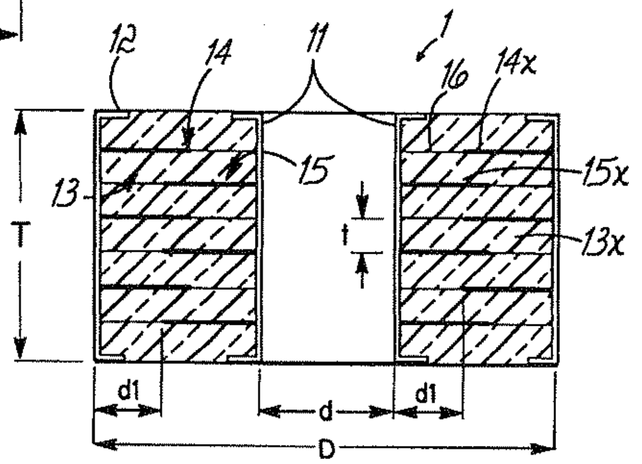

12
14
11
1
16
14x
15
15x
13
T
t
13x
d1
d
d1
D

FIG. 1B
PRIOR ART

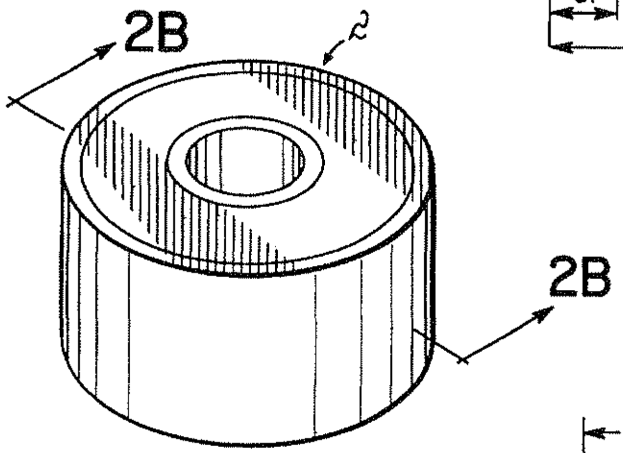


FIG. 2A

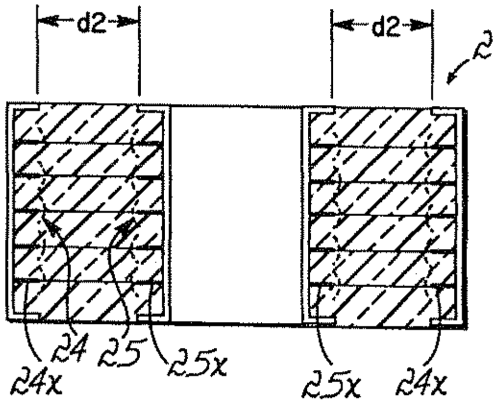

d2
d2
2
24x
24
25
25x
25x
24x

FIG. 2B

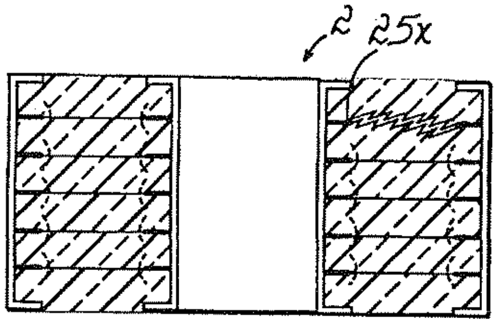


FIG. 3

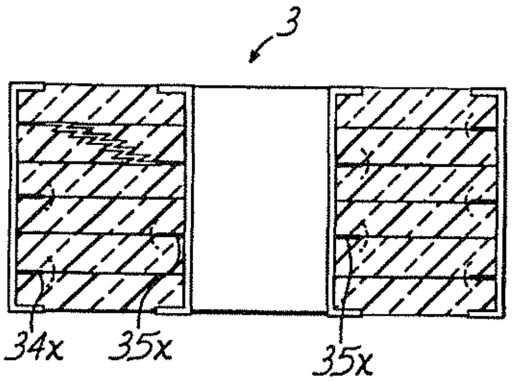

3
34x
35x
35x

FIG. 4

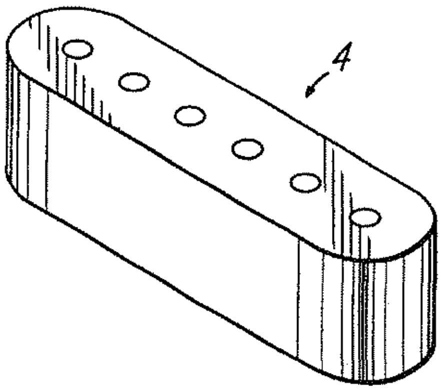


FIG. 5A

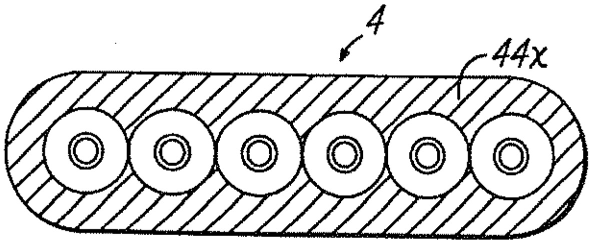


FIG. 5B

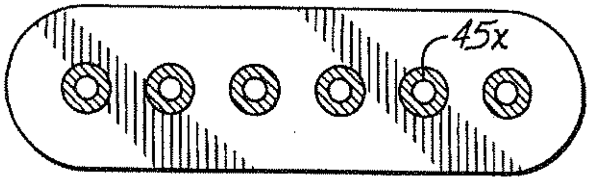


FIG. 5C

# FRINGE-FIELD NON-OVERLAPPING-ELECTRODES DISCOIDAL FEED-THROUGH CERAMIC FILTER CAPACITOR WITH HIGH BREAKDOWN VOLTAGE

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally concerns ceramic filter capacitors such as are most commonly discoidal in form.

The present invention particularly concerns the organization of internal electrodes within a discoidal feed-through ceramic filter capacitor so as to, by use of the electrodes' fringing fields, realize a compact capacitor of very high breakdown voltage.

2. Description of the Prior Art

The present invention will be seen to concern the size and placement of the internal electrodes within a multi-layer feed-through ceramic filter capacitor. Such a capacitor is commonly discoidal in shape, passing wires upon which are carried electrical signals to be filtered through one or more holes that are most commonly aligned to the axis of the disc. (Other geometries are, however, possible. See, for example, U.S. Pat. No. 5,822,174.) Typically multiple metal plate regions of each of a first, and of a second, electrode are typically located in partially overlapping positions upon alternating ceramic layers, thereby to create capacitance between these interleaved metal plate regions, and between the electrodes that are formed from the plate regions.

Capacitors so constructed are of particular use to filter electrical signals upon the wires and leads of implanted cardiac pacemakers and cardiac defibrillators. These latter devices use high voltages, commonly about 750 volts.

When the electrodes of a filter capacitor are subjected to high voltages—on the order of hundreds and, with safety margins, even thousands of volts—then their partially-overlapped metal plate regions are subject to develop voltage breakdown paths (1) through the ceramic to each other, and/or (ii) to oppositely-charged regions of the outside surface of the capacitor where electrical connections are made—all as is more thoroughly discussed in the DESCRIPTION OF THE PREFERRED EMBODIMENT section of this specification. According to this propensity, the alternating polarity metal plate regions of the two electrodes must be separated both (i) from each other, and (ii) from oppositely-charged regions at the exterior of the capacitor, by a reasonable thickness of ceramic.

Because (i) capacitance between spaced-parallel plate regions is a function of their separation, and (ii) plate density cannot be particularly high in a multi-layer capacitor where only an adequately thick ceramic buffer can insure such a high breakdown voltage as is desired, it has heretofore been believed that the metal plate regions of alternating polarity should be positioned (i) spaced-parallel (ii) in at least partial overlap along the axis of the discoidally-shaped ceramic body and of any hole(s) in this body. The simple reason that the metal plate regions are so located overlapping spaced parallel is so as to create capacitance along the elementary model of two parallel plate electrodes. Indeed, the formula for the capacitance of the conventional parallel-plate ceramic capacitor is:

$$Cap = \frac{kA}{d}$$

where Cap is the capacitance in farads, k is the dielectric constant in farads per meter, A is the area of electrode overlap in square meters and d is the distance of separation between plates in meters.

The present invention will be seen to show that capacitance suitable for filtering can be realized by an alternative metal plate configuration; a configuration that is much improved for voltage breakdown. A hallmark of this configuration, and of the present invention, will be seen to be the plate regions of each first and each second electrode pair (being that some filter capacitors can contain multiple electrodes) will be non-overlapping along the axis of the discoidally-shaped ceramic body, and along the axis of any hole(s) in this body.

Both the overlapping electrode plate regions of prior art multi-layer ceramic filter capacitors, and the multi-layer ceramic filter capacitors of the present invention totally lacking any such overlap in the, are highly visually distinctive (in views of the capacitor interiors). The overlapping of electrode plate regions is not much commented upon in the prior art, most likely because such has previously been deemed a fundamental and immutable basis of the construction of ceramic capacitors of all types—including feed-through filter capacitors. Accordingly, the next-following written descriptions of selected prior art patents, while amply showing the state of the art in multi-layer ceramic feed-through filter capacitors, do not deal directly with the present invention. The figures of these prior art patents do, however, clearly show that overlap of electrode plate regions that is obviated by the present invention.

For example, U.S. Pat. No. 4,148,003 to Colburn, et al. for a SERIES FEED-THROUGH CAPACITOR concerns a feed-through capacitor of the type for use in filters and the like and including discoidal ceramic capacitors arranged in stacked relationship and electrically connected in series. Series arrangement of the discoidal capacitors prevents shorting through the feed-through capacitor in the event of failure of one of the discoidal capacitors therein and results in substantially improved insertion loss characteristics when compared to feed-through capacitors having a single discoidal capacitor. Internal electrode metal plate regions are overlapping.

U.S. Pat. No. 5,333,095 to Stevenson, et al. for a FEED-THROUGH FILTER CAPACITOR ASSEMBLY FOR HUMAN IMPLANT concerns a feed-through filter capacitor assembly and related installation method are provided for shielding a conductive terminal pin or lead of the type used, for example, in an implantable medical device such as a heart pacemaker or defibrillator, against passage of external interference signals. The feed-through assembly includes a terminal pin subassembly having at least one terminal pin supported within a cylindrical conductive ferrule by a hermetically sealed insulator ring. The ferrule is adapted for mounting onto a conductive pacemaker housing, as by welding or brazing, to support the terminal pin for feed-through passage to the housing interior. A co-axial filter capacitor is mounted at an inboard side of the pacemaker housing, with capacitor electrode plate sets coupled respectively to the pacemaker housing and to the terminal pin by a conductive adhesive or the like. In one preferred form, multiple filter capacitors are provided in a substantially co-planar array within a common base structure, with each capacitor in association with a respective terminal pin. Internal electrode metal plate regions are again overlapping.

U.S. Pat. No. 5,751,539 also to Stevenson, et al. for an EMI FILTER FOR HUMAN IMPLANTABLE HEART DEFIBRILLATORS AND PACEMAKERS concerns an improved ceramic feed-through capacitor design which results in distinct advantages in EMI (electromagnetic interference) filtering and therapeutic wave form management for implantable defibrillators and pacemakers and the like. The invention provides ceramic capacitor electrode plate designs which provide both low impedance de-coupling for EMI suppression, and, at the same time provide an isolated common ground point through a separate coupling capacitor for electrical isolation of the filtered circuit from the metal case (usually titanium) of the defibrillator or the like. Such an arrangement allows the defibrillator HV (high voltage) output pulse to the heart to be referenced lead to lead (including reverse polarity), or from either lead to a common floating ground point or to the titanium case. The primary application of the invention is directed to implantable defibrillators where the output pulse to the heart is typically high voltage (up to 750 volts) and of short duration (typically in the $10^{-2}$ seconds, or 10 millisecond, range). The invention is equally applicable to implantable pacemakers. The invention is stated to be suited for a combination defibrillator (tachycardia) and pacemaker (bradycardia) unit where there are sense (heart monitoring), low voltage (pacing) and high voltage (defibrillator) output leads. Internal electrode metal plate regions are yet again overlapping.

U.S. Pat. No. 5,825,608 to Duva, et al. for a FEED-THROUGH FILTER CAPACITOR ASSEMBLY concerns a feed-through filter capacitor assembly is provided to pass a conductor into a housing of an electronic device while maintaining a hermetic seal and filtering spurious radio frequency signals. The assembly is particularly suitable for use in medical implant devices such as pacemakers. The feed-through filter capacitor assembly comprises a conductive bushing forming a cup that receives a filter capacitor body. The cup is located to one side of a pass-through portion including a passageway in which an insulating spacer is mounted. A plurality of wires pass through the filter capacitor body and spacer. The wires are contacted with inner plates of the capacitor and insulated from the bushing. Conductive polymer resin within the cup provides electrical continuity between outer contacts of the capacitor body and the conductive bushing. This arrangement also provides an effective heat sink for the filter capacitor body and protects the filter capacitor body from physical damage. The arrangement of a cup to the side of the pass-through portion allows sizing of the capacitor independently of the size of a housing hole provided to receive the assembly. Internal electrode metal plate regions are still yet again overlapping.

U.S. Pat. No. 5,999,398 to Maki, et al. for a FEED-THROUGH FILTER ASSEMBLY HAVING VARISTOR AND CAPACITOR STRUCTURE concerns a feed-through filter assembly such as may be used in an implantable medical device. The assembly includes a conductive mounting element which may be hermetically sealed to an outer housing of the implantable medical device. In many embodiments, the conductive mounting element will be a conductive canister in which a feed-through filter structure is located. Alternatively, the conductive mounting element may include a suitable sub-plate structure. Because the filter structure exhibits both varistor and capacitive characteristics, effective transient suppression and interference filtering is achieved in a single package. Secondary filtering may be provided downstream of the filter assembly for additional interference filtering at lower frequencies. Internal electrode metal plate regions are still yet again overlapping.

U.S. Pat. No. 6,008,980 again to Stevenson, et al. for a HERMETICALLY SEALED EMI FEED-THROUGH FILTER CAPACITOR FOR HUMAN IMPLANT AND OTHER APPLICATIONS concerns an integrated hermetically sealed feed-through capacitor filter assembly is provided for the shielding and de-coupling of a conductive terminal pin or lead of the type used, for example, in an implantable medical device such as a cardiac pacemaker or cardioverter defibrillator against passage of external interference signals, such as caused by digital cellular phones. The simplified feed-through assembly described herein eliminates the traditional terminal pin subassembly. In this novel approach, the ceramic feed-through capacitor itself forms a hermetic seal with a conductive pacemaker housing to which it is mounted by welding or brazing. The feed-through capacitor is configured such that its internal electrodes are not exposed to body fluids, with capacitor electrode plate sets coupled respectively to a conductive ferrule, pin or housing (which may be grounded) and to the non-grounded, or active, terminal pin(s) by conductive adhesive, soldering, brazing, welding or the like. In one preferred form, multiple feed-through filter capacitors are provided in a substantially coplanar array within a common base structure, with each capacitor in association with a respective terminal pin. Internal electrode metal plate regions are still yet again overlapping.

U.S. Pat. No. 5,905,627 to Brendel, et al. for an INTERNALLY GROUNDED FEED-THROUGH FILTER CAPACITOR concerns an internally grounded ceramic feed-through filter capacitor assembly that provides for the shielding and de-coupling of a conductive terminal pin or lead—of the type used, for example, in an implantable medical device such as a cardiac pacemaker or cardioverter defibrillator—against passage of external interference signals—such as those caused by digital cellular phones. The assembly includes a terminal pin subassembly having at least one terminal pin supported within a conductive ferrule by a hermetically sealed insulator structure. The ferrule is adapted for mounting onto a conductive substrate, such as a pacemaker housing, by welding or brazing to support the terminal pin subassembly for feed-through passage to the housing interior. A ceramic feed-through capacitor is mounted at an inboard side, with the capacitor electrode plate sets coupled respectively to a grounded lead and to the terminal pins(s) by conductive adhesive, soldering, brazing or the like. In preferred forms of the invention, multiple feed-through filter capacitors are provided in a substantially coplanar array within a common base structure, with each capacitor in association with a respective terminal pin. In this patent of Brendel, et al., the internal electrode metal plate regions are overlapping, as in all other patents.

## SUMMARY OF THE INVENTION

The present invention contemplates organizing the internal electrodes within a feed-through ceramic filter capacitor, such as is commonly discoidal in shape, so as to, by use of the electrodes' fringing fields, realize a filter capacitor that, nonetheless to being compact, has a very high breakdown voltage. Capacitors so constructed are of particular use in implanted cardiac pacemakers and especially, in consideration of the higher voltages used, implanted cardiac defibrillators.

A quality ceramic electromagnetic interference/radio frequency interference (EMI/RFI) filter capacitor in accordance with the most preferred embodiments of the present invention typically has a breakdown voltage reliably in excess of 4,000 volts, which is at least two, and more likely three, times better than the best capacitors of the prior art which are known to the inventors.

1. A Ceramic Filter Capacitor with Improved Internal Electrodes

In one of its aspects the present invention is embodied in a ceramic filter capacitor with internal electrodes improved in their size and placement so as to accord a much higher breakdown voltage to the capacitor than heretofore.

In some detail, the preferred filter capacitor is made from multiple ceramic layers as aggregate a substantially planar body. At least one hole in the body passes a wire that carries electrical signals which are to be filtered. A first metal area serves to line the body's hole, and to make electrical contact with any wire within the hole. A second metal area serves as a band over at least part, and typically all, of an exterior edge surface of the body. This second metal band is suitably electrically connected to ground. So far the capacitor construction is conventional, and preferred filter capacitor of the present invention so constructed has a quite normal external appearance.

However, in accordance with the present invention a number of first internal metallization areas, each in the shape of a relatively-smaller small-aperture disk, are centered about the body's hole each upon one of the body's multiple ceramic layers. Each of these apertured disk metallization areas makes at its internal edge surface electrical contact with the metal lining of the hole, thereby to serve as a first electrode of the capacitor.

Meanwhile, a number of second internal metallization areas, each in the shape of a relatively-larger large-apertured disk, are centered about the body's hole each upon one of the body's multiple ceramic layers. Each of these second metallization areas makes at its exterior edge surface electrical contact with the second metal band, thereby to serve as a second electrode of the capacitor.

Importantly, the first internal metallization areas as collectively constitute the first electrode, and the second internal metallization areas as collectively constitute the second electrode, are separated from each other in radial displacement from an imaginary centerline of the body's hole. This radial separation is typically large relative to both the minimum separations (i) between electrodes of opposite polarity, and (ii) between an internal electrode of one polarity and an external metal area of the other polarity, arising within discoidal feed-through EMI/RFI ceramic filter capacitors of the prior art. The larger separation between the electrodes of new geometry gives a higher breakdown voltage.

In user of this capacitor structure (i) upon electrical connection of the first metal to a wire passing through the hole, and (ii) upon electrical connection of the second metal to ground, a first fringing electrical field is developed at and between the first internal metallization areas, and a second fringing electrical field is developed at and between the second internal metallization areas. The metallization areas, and their fringing electrical fields, are internal within the ceramic body. A capacitance comparable with the capacitance of prior art feed-through capacitors is developed between these first and second fringing electrical fields. This capacitance is fully suitable to filter electromagnetic interference/radio frequency interference (EMI/RFI) present in electrical signals upon the wire.

The filter capacitor of the present invention is thus different not only in the sizes and the placement of its metallization areas, or electrodes, within the ceramic body, but by its intentional use, and coupling, of fringing fields as a primarily basis of a capacitance developed between the two electrodes. This is unusual: fringing fields are no longer secondary, but are rather primary, to capacitor performance.

The separation (i) between each two electrodes of a pair, and (ii) between any of the metallization areas as do collectively form one of the electrodes and those metallization areas as do collectively form the other one of the electrodes, is quite great relative to the separations arising between (i) the two electrodes, and (ii) the metallization areas, of previous ceramic filter capacitors. Accordingly, the breakdown voltage of a ceramic filter capacitor so constructed is already superior. However, in accordance with the present invention, the strength of the dielectric separation between opposite electrodes is still further improved.

Namely, the electrode metallization areas, or plates, are preferably located upon alternating layers. This makes an embodiment where any path of voltage breakdown will have to penetrate radially through, as well as transversely along, at least one ceramic layer. Voltage breakdown along such a path in two—both radial and longitudinal—directions at the same time is strongly resisted, giving this embodiment of a multi-layer ceramic feed-through capacitor in accordance with the present invention an even higher breakdown voltage than the already impressively increased breakdown voltage of the basic embodiment of the invention.

2. A Ceramic Filter Capacitor Improved for the Strength of Dielectric Separation Between Electrodes

In another of its aspects the present invention may be considered to be embodied in a ceramic filter capacitor improved for the strength of dielectric separation between its internal electrodes. The material or nature of the capacitor dielectric—ceramic—is not changed: the size and placement of the metallization regions—which regions in aggregate produce each of the electrodes—is instead improved. The metallization regions are sized and placed so as to make that any path by which the capacitor will suffer breakdown will have a much greater resistance (requiring a much higher voltage to induce breakdown) than heretofore.

The basic approach is (1) to separate the metallization areas widely—as first described in section 1. above—plus (2) to place each metallization region of each electrode on a separate ceramic layer from the metallization regions of the other electrode. The several metallization regions of each electrode are interleaved, with each metallization layer of each electrode being both (i) radially and (ii) longitudinally separated from the metallization areas of the other-electrode.

Accordingly, a ceramic filter capacitor so constructed has (1) its first internal metallization areas upon a first group of the multiple ceramic layers, (2) its second internal metallization areas upon a second group of the multiple ceramic layers, and (3) its first group of ceramic layers and first internal metallization areas interleaved with the second group of ceramic layers and second metallization areas. By this construction the first and the second metallization areas are never on the same ceramic layer, but are always separated, first metallization area to second metallization area, not only by the radial distance of separation, but also by a thickness of at least one ceramic layer.

Still further in accordance with the present invention, the ceramic filter capacitor may be constructed in diverse shapes, including in (i) the substantial shape of an apertured disk with one substantially central hole, or in (ii) the substantial shape of a multi-apertured substantially planar body with multiple holes each of which is capable of accepting at least one lead or wire. Regardless of the particular capacitor shape, the placement of the hole(s), such as by process of drilling, is not particularly dimensionally critical—as it has been in the past—because the holes simply pass into internal disk-shaped metallization areas (part of the first electrode) that are substantially larger than is the hole.

3. A Feed-Through Multi-layer Ceramic Filter Capacitor with Non-Overlapping Electrodes

According to the unique placement of the electrodes with feed-through multi-layer ceramic filter capacitors in accordance with the present invention, the invention may be broadly conceived to be embodied in a ceramic filter capacitor that is improved for the strength of dielectric separation between its internal electrodes.

It will be recognized that a common-form, prior art, multi-layer ceramic feed-through filter capacitor commonly has (1) a substantially monolithic body of layered ceramic dielectric material with at least one hole, suitable to accept an electrical conductor, passing through at least some layers of the body; (2) a number of conductive first electrode plates, encased within the body on an associated plurality of ceramic layers, electrically connectable to an electrical conductor within the hole; and (3) a number of conductive second electrode plates, encased within the body on an associated plurality of ceramic layers, electrically connectable to ground.

In this general structure the present invention is characterized in that the first plurality of conductive first electrode plates are spatially non-overlapping with the second plurality of conductive second electrode plates along any imaginary axis that is parallel to an axis of the hole.

These non-overlapping plates can be upon the same, or upon different, ceramic layers. Namely, and as a first alternative, at least some of the ceramic layers associated with the conductive first electrode plates can be the selfsame ceramic layers as are associated with the conductive second electrode plates. This makes that at least some of the conductive first, and the conductive second, electrode plates will be upon the same ceramic layers.

Alternatively, it can be that none of the ceramic layers associated with the conductive first electrode plates are the same as any ceramic layers associated with the conductive second electrode plates. This makes that at least one ceramic layer located between each conductive first, and each conductive second, electrode plate.

4. An Improvement to Discoidal Feed-Through Multi-Layer Ceramic Filter Capacitor

Still yet another way of describing the unique placement of the electrodes with feed-through multi-layer ceramic filter capacitors in accordance with the present invention is as follows.

The invention may be broadly conceived to be embodied in a feed-through filter capacitor having (1) a substantially discoidal dielectric body with (1a) a major axis, (1b) at least one hole, aligned parallel to the major axis, suitable to accept an electrical conductor, and (1c) an external rim region. The capacitor further has (2) a first set of electrodes, located spaced-parallel within the body transverse to the body's axis, electrically connected to an electrical conductor within the hole, and (2) a second set of electrodes, also located spaced-parallel within the body transverse to the body's axis, electrically connected to ground at the body's rim. The electrical conductor is "fed through" the body's hole. This "feed-through" capacitor structure serves to filter to ground any electrical signal upon the electrical conductor fed through the body's hole. All this is conventional.

To this structure the present invention constitutes an improvement wherein the first set of electrodes are non-overlapping with the second set of electrodes along any imaginary axis parallel to the axis of the at least one hole. This "non-overlapping" simply means that no imaginary axis parallel to the axis of the at least one hole will pass through both an electrode of the first set and, also, and electrode of the second set.

The substantially discoidal dielectric body is preferably multi-layer ceramic, with the first and the second sets of electrodes being metal upon the ceramic layers.

As in section 3., above, the first and the second sets of electrodes may be upon either the same, or different, ones of the ceramic layers. Location of the electrodes on different, interleaved, layers is preferred.

These and other aspects and attributes of the present invention will become increasingly clear upon reference to the following drawings and accompanying specification.

## BRIEF DESCRIPTION OF THE DRAWINGS

Referring particularly to the drawings for the purpose of illustration only and not to limit the scope of the invention in any way, these illustrations follow:

FIG. 1*a* is a diagrammatic perspective view showing a prior art ceramic discoidal feed-through ceramic filter capacitor, and FIG. 1*b* is a cut-away plan view of the internal electrode structure of this prior art capacitor.

FIG. 2*a* is a diagrammatic perspective view showing a first preferred embodiment of a ceramic discoidal feed-through ceramic filter capacitor with high breakdown voltage in accordance with the present invention, and

FIG. 2*b* is a cut-away plan view of the internal electrode structure of this capacitor.

FIG. 3 is a detail cut-away plan view showing the internal electrodes of a laminated first preferred embodiment of a ceramic discoidal feed-through ceramic filter capacitor with high breakdown voltage in accordance with the present invention, which first embodiment capacitor was previously seen in FIG. 2.

FIG. 4 is a detail cut-away plan view showing the internal electrodes of a second, most preferred, embodiment of a laminated ceramic discoidal feed-through ceramic filter capacitor with high breakdown voltage in accordance with the present invention.

FIG. 5*a* is a perspective view of a multi-hole ceramic filter capacitor with high breakdown voltage in accordance with the present invention;

FIG. 5*b* is a top plan view of a typical first, ground, exterior metallization plane area of this capacitor; and

FIG. 5*c* is a top plane view of a typical second, interior, metallization plane area of this capacitor.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

The following description is of the best mode presently contemplated for the carrying out of the invention. This description is made for the purpose of illustrating the general principles of the invention, and is not to be taken in a limiting sense. The scope of the invention is best determined by reference to the appended claims.

Although specific embodiments of the invention will now be described with reference to the drawings, it should be understood that such embodiments are by way of example only and are merely illustrative of but a small number of the many possible specific embodiments to which the principles of the invention may be applied. Various changes and modifications obvious to one skilled in the art to which the invention pertains are deemed to be within the spirit, scope and contemplation of the invention as further defined in the appended claims.

In the design of multi-layer capacitors the electrode plates are commonly overlapped so as to derive the highest capacitance. The formula for capacitance is:

$$Cap = \frac{kA}{d}$$

where Cap is the capacitance in farads, k is the dielectric constant in farads per meter, A is the area of electrode overlap in square meters and d is the distance of separation between plates in meters. Although d would desirably be minimized for greatest capacitance, for high voltage capacitors d cannot be indefinitely small or else the capacitor will be subject to failure from voltage breakdown of the insulating ceramic dielectric.

For example, a typical prior art multi-layer ceramic feed-through capacitor 1 is shown in perspective view in FIG. 1*a*, and in cut-away side plan view in FIG. 1*b*. The capacitor 1 has a central hole, or bore, that is typically surfaced with first conductive metal 11, and external rim surface, or circumference, that is typically surfaced with a second conductive metal 12. Conductive metals 11 and 12 may be the same type of metal. Inside the capacitor 1, which is substantially made from multiple layers 13*x* of ceramic 13, are a number of ring-shaped first metallization areas, or plates, 14*x* as do constitute in aggregate a first electrode 14, and a number of ring-shaped second metallization areas, or plates, 15*x* as do constitute in aggregate a second electrode 15.

The external diameter D of the prior art multi-layer ceramic feed-through capacitor 1 of FIG. 1 is typically about 0.105 inch, the internal diameter d about 0.035 inch, and the overall thickness T about 0.065 inch. A typical ceramic dielectric will have a voltage breakdown rating of 100 volts per mil thickness. For a capacitor 1 designed for 1000 volts breakdown voltage, a typical ceramic dielectric thickness t between adjacent plates 11, 12 will thus be 0.010 inch.

Another aspect of high voltage ceramic capacitor design is that the distance dl of separation between any electrode 14, 15 and respective external metal 11, 12 along the direction of the layers 13*x*—the horizontal direction in FIG. 1*b*—should be 50% greater than in the direction transverse to these layers 13*x*, or the vertical direction in FIG. 1*b*. This is because voltage breakdown in more likely to occur along the unavoidable imperfections of the seam 16 between layers 13*x*. This requires that the distance dl should be 1.5't=1.5'(0.010 inch)=0.015 inch.

The complete internal design of the prior art feed-through multi-layer ceramic capacitor 1 shown in FIG. 1*b* for a 1000 volt rating thus dictates a 0.010 inch layer-to-layer thickness t, and a 0.015 inch end margin dl (to both electrodes 14, 15). According a 7.5 mil ceramic cover on the top and the bottom of the capacitor 1, the number of active internal plates 14*x*, 15*x* is thus three of each polarity, with a total overlapping area A of $((0.0375)^2-(0.0325)^2)\pi=(0.001406-0.001506)\pi=0.00035\pi=0.001099$ square inches.

Especially when the thickness t grows large—as it must to prevent voltage breakdown in available ceramic materials at high electrode voltage differentials—a substantial portion of the overall capacitance starts to accrue from what is called the "fringe effect". Fringe effect capacitance is always present in, inter alia, (i) the end of each plate 14*x*, 15*x* of the respective electrodes 14, 15 and (ii) the respective exterior metal 11, 12 termination of opposite polarity. It is simply that when the capacitor is used at a lower voltage, and smaller plate-to-plate spacing t, then this fringe capacitance is a negligible contribution to the overall capacitance, and is disregarded. However, in a high voltage multi-layer ceramic capacitor 1 with relatively large plate-to-plate spacing t the fringe capacitance commences to be a sizable, measurable, portion of the total capacitance.

In the discoidal feed-through capacitors 2–4 of the present invention—shown in FIGS. 2–5, this "fringe effect" capacitance is put to beneficial use. Indeed, multi-layer ceramic capacitors in accordance with the present invention are constructed specifically so as to maximize this fringe effect, as exemplified by a first preferred embodiment of a capacitor 2 in accordance with the present invention shown in FIG. 2 (and FIG. 3). The exterior, and exterior measurements, of the

capacitor 2 may be, as shown in FIG. 2*a*, identical to the prior art capacitor 1 shown in FIG. 1*a*. The mode and manner of electrical connection is likewise the same. This general principle is the same for multi-layer ceramic capacitors of diverse other form factors: the present invention concerns the electrode plates 24*x*, 25*x* on the interior of the capacitor 2.

In the preferred first embodiment of a capacitor 2 in accordance with the present invention as illustrated in cross-sectional side view in FIG. 2*b*, the number of plates of each electrode 24, 25 is typically two to three times (×2–×3) the number of electrode plates 14*x*, 15*x* in the prior art capacitor 1 (shown in FIG. 1). The plates 24*x*, 25*x* are desirably placed as closely as is practical (necessitating an increased number of relatively thinner ceramic layers 23*x*) so that the combined plates 24*x* and 25*x* act nearly as continuously vertical electrodes 24, 25. With sufficiently numerous, and closely spaced, horizontal electrode plates the electric field lines of (the plates of) each electrical polarity merge, and capacitance can effectively be calculated as the area of, and distance between, two cylinders. The effective area of the new design capacitor 2 of the present invention is $\pi \times d \times h = (3.14)\times(0.070)\times(0.060)=0.01318$ $in^2$, or approximately twelve times (×12) the area of the conventional prior art capacitor 1 of FIG. 1.

In reality, the capacitance of the capacitor 2 of the present invention is not twelve times (×12) as much as the prior art capacitor 1 because there is some contribution by "fringe effect" capacitance in the capacitor 1 of conventional design. However, when comparing such capacitors as do achieve essentially identical capacitance, the capacitor 2 of the present invention enjoys a significantly higher breakdown voltage. This is first because, as illustrated for a typical first embodiment capacitor 1 in FIGS. 2*b* and 3, and the second embodiment capacitor 3 shown in FIG. 4, for a typical 0.0075 inch extension of the plates toward each other there is a distance of separation d2 between the electrode plates 24*x*, 25*x* of opposite polarities that is typically about (0.035–0.0075–0.0075) inch=0.020 inch, or twice (×2) the typical 0.010 inch electrode (minimum) separation for a typical 1000 volt prior art capacitor 1 as shown in FIG. 1.

The "fringe effect" electric field is attempted to be illustrated in FIG. 2*b* by the "arcs" appearing around the interior butt ends of the electrode plates 24*x*, 25*x* of the capacitor 2. These illustrated "arcs" do not represent any physical structure.

Still further the present invention contemplates placing the successive plates 34*x*, 35*x* of each electrode 34, 35 on alternating layers, as illustrated for the second embodiment capacitor 3 in FIG. 4. The first embodiment capacitor 2 of FIGS. 2*b* and, in greater detail wherein the laminations of the multi-layer ceramic may be imagined in FIG. 3, can suffer voltage breakdown at, and along—inter alia—the path shown in jagged line in FIG. 3. This path is along a boundary of the laid-up laminated layers of the multi-layer ceramic body. Despite the considerable distance of this breakdown path, it is relatively more susceptible to failure than is any voltage breakdown path proceeding through a ceramic layer 23*x*.

Consider now the most-preferred second embodiment of a capacitor 3 in accordance with the present invention shown in FIG. 4. The plates of each electrode—interior and exterior—are upon alternating ceramic layers 33*x*. A potential voltage breakdown path is again shown in jagged line in FIG. 4. Proceeding of necessity both along (i.e., in the horizontal direction in FIG. 4), and through (i.e., in the vertical direction in FIG. 4), a boundary between laid-up ceramic layers **33**x, this failure path is uncommon, and will not normally occur until extreme voltages are reached.

Capacitors **2**, **3** in accordance with the present invention having identical form factors and materials to the prior art capacitor **1** reliably double the (×2) voltage breakdown threshold from the previous 1,000 volts to 2,000 volts and more. Entire production batches of capacitors **3** test to 3,000 volts, and selected individual capacitors **3** test in excess of 4,000 volts.

The principles of the present invention are readily extended to multi-layer ceramic feed-through capacitors of alternative configurations. For example, the common "race-track" discoidal form capacitor **4** of FIG. **5**a accommodates six leads, or wires (not shown) carrying electrical signals that are to be filtered. In accordance with the present invention, a typical internal plate **44**x of one electrode **44**, normally the ground, will look as shown in top plan cut-away view in FIG. **5**b, and a plate **45**x of the other electrode **45** can look as shown in FIG. **5**c.

Note that plates **45**x of the internal electrode **45** are shown somewhat abbreviated in annular width in FIG. **5**c relative to the width that they had in, for example, FIGS. **2**b, **3** and **4**. A practitioner of the art of capacitor design will recognize that a juxtaposition of the fringing fields of the internal electrodes of each polarity, as is best shown in FIG. **2**b, is what is desired, and that this can be realized without being hidebound as to the size and extent of the internal electrodes, or plates. The interior electrode might in particular be smaller because there will be some fringing fields directly to the wire, or lead, that passes through the central hole.

Note also that any misalignment of the central hole in the classic prior art feed-through filter capacitor **1** of FIG. **1** degraded capacitor performance both in (i) capacitance and (ii) breakdown voltage. New construction feed-through filter capacitors **2**–**4** in accordance with the present invention as shown in FIGS. **2**–**5** are relatively immune to the placement of the central hole(s). So long as the plates of the central electrode **25**, **35**, **45**—normally considerably larger than is the hole—are reliably contacted, capacitor performance does not much vary with hole, or holes, misalignment(s). (The small annulus of the interior electrode of FIG. **5**c requires somewhat greater accuracy in the placement of the hole relative to the inner interior electrode—but even if the hole (and the wire, or lead, passing therethrough) was to be so far off center so as break the annulus of an inner interior electrode plate **45**x the capacitor would still work!)

In accordance with the preceding explanation, variations and adaptations of the feed-through multi-layer ceramic filter capacitors with improved electrode structures in accordance with the present invention will suggest themselves to a practitioner of the ceramic capacitor design arts. For example, the layers need not be laminated, but could be created as a toroidal winding about single central hole.

In accordance with these and other possible variations and adaptations of the present invention, the scope of the invention should be determined in accordance with the following claims, only, and not solely in accordance with that embodiment within which the invention has been taught.

What is claimed is:

**1**. A feed-through multi-layer ceramic filter capacitor comprising:

a substantially monolithic body of layers of ceramic dielectric material with at least one electrical contact in a hole suitable to accept an electrical conductor passing through at least some layers of the dielectric material

first electrode plates electrically connected to the one electrical contact in the hole, each of the first electrode

plates being disposed on a layer of dielectric material within the body, and

second electrode plates electrically connected to a ground, each of the second electrode plates being disposed on a layer of dielectric material within the body, the second electrode plates forming the capacitor with the first electrode plates without any intervening electrode plates and the second electrode plates spatially non-overlapping with the first electrode plates along any imaginary axis parallel to an axis of the hole.

**2**. The feed-through multi-layer ceramic filter capacitor according to claim **1** wherein each of the first electrode plates is disposed on a different layer of dielectric material and each of the second electrode plates is disposed on a layer of dielectric material common to one of the first electrode plates.

**3**. The feed-through multi-layer ceramic filter capacitor according to claim **1** wherein each of the first and second electrode plates is disposed on a different layer of dielectric material.

**4**. In a feed-through filter capacitor

a substantially discoidal dielectric body having

a plurality of stacked layers of dielectric material,

a major axis extending centrally through the discoidal dielectric body,

at least one hole aligned parallel to the major axis and adapted to accept an electrical conductor, and

an external rim region;

a first set of electrodes located within the body transverse to the major axis, each of the first electrodes being disposed on a layer of dielectric material and adapted to be electrically connectable to an electrical conductor within the at least one hole; and

a second set of electrodes located within the body transverse to the major axis, each of the second electrodes being disposed on a layer of dielectric material and adapted to be electrically connectable to ground at the body's rim; so as to filter to ground any electrical signal upon any electrical conductor fed through the body's hole, the second set of electrodes forming the capacitor with the first set of electrodes without any intervening electrode plates, and the first set of electrodes non-overlapping with the second set of electrodes along any imaginary axis parallel to the major axis.

**5**. The feed-through filter capacitor according to claim **4** wherein the first and the second sets of electrodes being metal upon the ceramic layers.

**6**. The feed-through filter capacitor according to claim **5** wherein each of the first set of electrodes is disposed on a different layer of dielectric material and each of the second set of electrodes is disposed on a layer of dielectric material common to one of the first set of electrodes.

**7**. The feed-through filter capacitor according to claim **5** wherein each of the first and second electrode plates is disposed on a different layer of dielectric material.

**8**. A feed-through ceramic filter capacitor comprising:

multiple ceramic layers forming a body;

at least one hole in the body adapted to receive an electrical conductor carrying electrical signals to be filtered;

a first metal lining the at least one hole and adapted to electrically contact an electrical conductor within the hole;

a plurality of first metallization areas in the shape of apertured disks and having respective apertures centered about the at least one hole upon respective ceramic layers, each first metallization area making at an aperture edge surface electrical contact with the metal lining of the hole so as to serve as a first electrode of a capacitor;

a metal band extending over at least part of an exterior edge surface of the body, the metal band adapted to be electrically connected to ground;

a plurality of second metallization areas having respective apertures centered about the at least one hole upon respective ceramic layers, each second metallization area making at its exterior edge surface electrical contact with the second metal band so as to serve as a second electrode of a capacitor;

the plurality of first metallization areas collectively constitute a first electrode, and the plurality of second metallization areas collectively constitute a second electrode separated from the first electrode radially from a centerline of the body's hole; and

wherein upon the electrical connection of the first metal to an electrical conductor passing through the at least one hole, and electrical connection of the second metal to ground, a first fringing electrical field is developed at and between the plurality of first metallization areas, and a second fringing electrical field is developed at and between the plurality of second metallization areas, and a fringe-effect capacitance is created by the first and second fringing fields suitable for filtering electromagnetic interference/radio frequency interference existing in electrical signals upon the electrical conductor.

**9**. The ceramic filter capacitor according to claim **8**

wherein the plurality of first internal metallization areas are upon a first plurality of the multiple ceramic layers;

wherein the plurality of second internal metallization areas are upon a second plurality of the multiple ceramic layers; and

wherein the first plurality of the multiple ceramic layers is interleaved with the second plurality of the multiple ceramic layers, making that the first and the second metallization areas are never on the same layer, but are always separated, first metallization area to second metallization area, not only by the radial distance of separation, but also by a thickness of a ceramic layer.

**10**. The ceramic filter capacitor according to claim **8** wherein the body has one substantially central hole.

**11**. The ceramic filter capacitor according to claim **8** wherein the body has multiple holes each of which is capable of accepting at least one wire.

**12**. A feed-through filter capacitor comprising:

layers of dielectric material having at least one hole passing therethrough;

first electrodes disposed on layers of the dielectric material and extending in a first direction substantially perpendicular to a centerline of the at least one hole;

second electrodes disposed on layers of the dielectric material and extending in the first direction; and

the layers of dielectric material being sufficiently thin and the first and second electrodes being sufficiently numerous that a capacitor is formed substantially wholly by fringe-effect capacitance between the first and second electrodes.

**13**. The feed-through filter capacitor of claim **12** wherein the layers of dielectric material are a ceramic dielectric material.

**14**. The feed-through filter capacitor of claim **13** wherein the layers of dielectric material comprise a body of the

feed-through filter capacitor having an external surface and the feed-through filter capacitor further comprises:

a first electrode contact connected to the first electrodes and formed over a portion of the external surface, the first electrode contact adapted to be electrically connectable to an external contact; and

a second electrode contact electrically connected to the second electrodes and disposed in the at least one hole, the second electrode contact adapted to be electrically connectable to an electrical conductor extending through the at least one hole.

**15**. The feed-through filter capacitor of claim **14** wherein

each of the first electrodes being disposed on a layer of the dielectric material; and

each of the second electrodes being disposed on the layer of the dielectric material with a respective one of the first electrodes.

**16**. The feed-through filter capacitor of claim **14** wherein

each of the first electrodes being disposed on a first layer of the dielectric material; and

each of the second electrodes being disposed on a second layer of dielectric material different from the first layer.

**17**. A feed-through filter capacitor comprising:

layers of dielectric material forming a body having an external surface and having a hole passing therethrough;

a first electrode contact formed over a portion of the external surface and adapted to be electrically connectable to an external contact;

a second electrode contact disposed in the hole and adapted to be electrically connectable to an electrical conductor extending through the hole;

spatially overlapping first electrodes disposed on layers of the dielectric material and electrically connected to the first electrode contact; and

spatially overlapping second electrodes disposed on layers of the dielectric material and electrically connected to the second electrode contact, wherein all electrodes in the capacitor spatially overlapping the second electrodes are connected to the second electrode contact.

**18**. The feed-through filter capacitor of claim **17** wherein all electrodes in the capacitor spatially overlapping the first electrodes are connected to the first electrode contact.

**19**. The feed-through filter capacitor of claim **17** wherein a capacitor is formed substantially wholly by fringe-effect capacitance between the first and second electrodes.

**20**. The feed-through filter capacitor of claim **17** wherein the dielectric material is a ceramic dielectric material.

**21**. The feed-through filter capacitor of claim **17** wherein

each of the first electrodes being disposed on a layer of the dielectric material; and

each of the second electrodes being disposed on the layer of the dielectric material with a respective one of the first electrodes.

**22**. The feed-through filter capacitor of claim **17** wherein

each of the first electrodes being disposed on a first layer of the dielectric material; and

each of the second electrodes being disposed on a second layer of dielectric material different from the first layer.

**23**. A feed-through filter capacitor comprising:

layers of dielectric material forming a body having an external surface and having a hole passing therethrough;

a first electrode contact formed over a portion of the external surface and adapted to be electrically connectable to an external contact;

a second electrode contact disposed in the hole and adapted to be electrically connectable to an electrical conductor extending through the hole;

spatially overlapping first electrodes disposed on layers of the dielectric material and electrically connected to the first electrode contact; and

spatially overlapping second electrodes disposed on layers of the dielectric material and electrically connected to the second electrode contact, wherein all electrodes in the capacitor spatially overlapping the first electrodes are connected to the first electrode contact.

**24**. A feed-through filter capacitor comprising:

layers of dielectric material having at least one hole passing therethrough;

first electrodes disposed on layers of the dielectric material and extending in a first direction substantially perpendicular to a centerline of the hole;

second electrodes disposed on layers of the dielectric material and extending in the first direction, the second electrodes forming a capacitor with only the first electrodes; and

any one of the first and second electrodes being non-overlapping with any of an other of the first and second electrodes in a second direction substantially parallel to a centerline of the hole.

**25**. A feed-through filter capacitor comprising:

layers of dielectric material having at least two holes passing therethrough;

first electrodes disposed on layers of the dielectric material and extending in a first direction substantially perpendicular to a centerline of the hole;

second electrodes disposed on layers of the dielectric material and extending in the first direction;

third electrodes disposed on layers of the dielectric material and extending in the first direction; and

the layers of dielectric material being sufficiently thin and the first, second and third electrodes being sufficiently numerous that a first capacitor is formed substantially wholly by fringe-effect capacitance between the first and second electrodes, and a second capacitor is formed substantially wholly by fringe-effect capacitance between the first and third electrodes.

**26**. The feed-through filter capacitor of claim **25** wherein the dielectric material are a ceramic dielectric material.

**27**. The feed-through filter capacitor of claim **26** wherein the layers of dielectric material comprise a body of the feed-through filter capacitor having an external surface and the feed-through filter capacitor further comprises:

a first electrode contact connected to the first electrodes and formed over a portion of the external surface, the first electrode contact adapted to be electrically connectable to an external contact;

a second electrode contact connected to the second electrodes and disposed in a first hole, the second electrode contact adapted to be electrically connectable to an electrical conductor extending through the first hole; and

a third electrode contact connected to the third electrodes and disposed in a second hole, the third electrode contact adapted to be electrically connectable to an electrical conductor extending through the second hole.

**28**. The feed-through filter capacitor of claim **27** wherein

each of the first electrodes being disposed on a layer of the dielectric material; and

each of the second electrodes being disposed on the layer of the dielectric material with a respective first electrode; and

each of the third electrodes being disposed on the layer of the dielectric material with the respective first electrode.

**29**. The feed-through filter capacitor of claim **27** wherein

each of the first electrodes being disposed on a first layer of the dielectric material; and

each of the second electrodes being disposed on a second layer of the dielectric material different from the first layer; and

each of the third electrodes being disposed on the second layer of the dielectric material with a respective second electrode.

**30**. A feed-through filter capacitor comprising:

layers of dielectric material forming a body having an external surface and having a plurality of holes passing therethrough;

a first electrode contact formed over a portion of the external surface and adapted to be electrically connectable to an external contact;

second electrode contacts, each of the second electrode contacts being disposed in a different one of the holes and adapted to be electrically connectable to an electrical conductor extending through the one of the holes;

spatially overlapping first electrodes disposed on layers of the dielectric material and electrically connected to the first electrode contact; and spatially overlapping sets of second electrodes, each set of

second electrodes being disposed on layers of the dielectric material and electrically connected to a respective one of the second electrode contacts, wherein all electrodes in the capacitor spatially overlapping a set of second electrodes are connected to the respective one of the second electrode contacts.

**31**. The feed-through filter capacitor of claim **30** and all electrodes in the capacitor spatially overlapping the first electrodes are connected to the first electrode contact.

**32**. The feed-through filter capacitor of claim **30** wherein capacitors are formed substantially wholly by fringe-effect capacitance between the first electrodes and each set of second electrodes.

**33**. The feed-through filter capacitor of claim **30** wherein the dielectric material is a ceramic dielectric material.

**34**. The feed-through filter capacitor of claim **30** wherein

each of the first electrodes being disposed on a layer of the dielectric material; and

each set of second electrodes being disposed on the layer of the dielectric material with a respective one of the first electrodes.

**35**. The feed-through filter capacitor of claim **30** wherein

each of the first electrodes being disposed on a first layer of the dielectric material; and

each set of second electrodes being disposed on a second layer of dielectric material different from the first layer.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

# CERTIFICATE OF CORRECTION

PATENT NO. : 6,545,854 B2
DATED : April 8, 2003
INVENTOR(S) : Trinh et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 1,
Line 38, subparagraphs do not match. Please delete "(1)", and insert therefor -- (i) --.

Column 2,
Line 13, after "any such overlap", delete "in the".
Line 41, after "installation method", delete "are".

Column 3,
Line 23, after "capacitor assembly", delete "is".
Line 66, after "filter assembly", delete "is".

Column 4,
Line 39, delete "pins(s)", and insert therefor -- pin(s) --.

Column 5,
Line 43, delete "user", and insert therefor -- use --.
Line 61, delete "primarily", and insert therefor -- primary --.

Column 6,
Line 38, delete "other-electrode", and insert therefor -- other electrode --.

Column 7,
Line 47, subparagraphs do not match. Please delete "(2)", and insert therefor -- (3) --.
Line 59, after "first set and, also," delete "and".

Column 9,
Line 35, delete "1.5' t =1.5' (0.010 inch)" and insert therefor -- 1.5 t=1.5 (0.010 inch) --.

Column 15,
Line 24, delete "an other", and insert therefor -- another --.
Line 46, after "Claim 25 wherein the", insert -- layers of --.

UNITED STATES PATENT AND TRADEMARK OFFICE

# CERTIFICATE OF CORRECTION

PATENT NO. : 6,545,854 B2
DATED : April 8, 2003
INVENTOR(S) : Trinh et al.

Page 2 of 2

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 16,
Line 34, paragraph indents are not correct. After "first electrode contact; and", begin a new paragraph with "spatially".

Signed and Sealed this

Fourth Day of November, 2003

JAMES E. ROGAN
*Director of the United States Patent and Trademark Office*

IN THE UNITED STATES DISTRICT COURT

FOR THE SOUTHERN DISTRICT OF CALIFORNIA

| | |
|---|---|
| PRESIDIO COMPONENTS, INC.,<br>Plaintiff,<br>v.<br>AMERICAN TECHNICAL CERAMICS CORPORATION,<br>Defendant. | Civil Action No. 08cv335 IEG (NLS)<br>**CLAIM CONSTRUCTION ORDER** |

Presently before the Court is the construction of disputed terms of the asserted claims of U.S. Patent No. 6,816,356 ("the '356 patent").

**BACKGROUND**

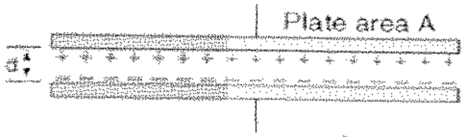
The disputed patent is entitled "Integrated Broadband Ceramic Capacitor Array." A capacitor is a device conventionally comprised of two metal plates separated by a non-conductor of direct electric current. This non-conductive material is known as a "dielectric." Dielectric material includes air or ceramic.

A capacitor is charged by coupling its plates to an electrical source. Since electricity passes easily through the metal plates—which are electrical conductors—but not the dielectric, a positive electrical charge accumulates on one plate and a negative charge accumulates on the other plate. Or, put another way, electrons are introduced on one of the metal plates and electrons are depleted on the

EXHIBIT 6 Ewell 8-1-08

other. When thus charged, the capacitor stores energy which can then be released by connecting the plates via an external path and permitting current to flow from one plate to the other. The electrons will flow off the negatively charged plate and to the positively charged plate, bringing the two plates to equal relative voltage.

f

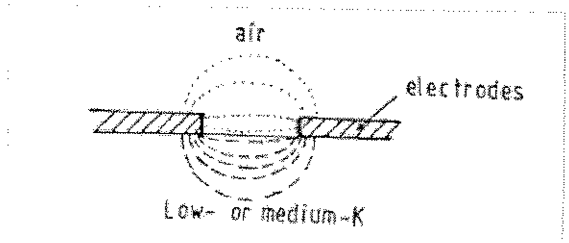


$C_{DC} \simeq \frac{d}{Voltage}$

PARALLEL PLATE CAPACITOR

Below is an example of a typical "parallel plate capacitor" described above and utilized in the 356 patent. The capacitor is formed by positioning two conductive plates in parallel and separating them by a dielectricic.

One other type of capacitor utilized by the subject patent is a "fringe-effect capacitor." A "fringe-effect capacitor" is formed by positioning the ends of two conductors in an edge-to-edge relationship. Here is an illustration.



FRINGE-EFFECT CAPACITOR

The ability of a capacitor to store charge per unit of voltage applied across its plate is its "capacitance." Capacitance depends on the spacing of the conductive plates and the specific properties of the dielectric material used.

The '356 patent discloses and claims a capacitor consisting of a network of capacitors. The geometry and spacing of the multiple conductive and non-conductive layers of the multilayer capacitor forms multiple parallel-plate capacitors and fringe-effect capacitors.

Below is an embodiment of the capacitor described by the '356 patent. The capacitor contains several conductive plates positioned inside the dielectric body (e.g., structures 10 and 11). The positioning of these plates form parallel plate capacitors. A fringe-effect capacitor is formed in the

• Cap (ac) = f (frequency of measurement) space between 72 and 74.

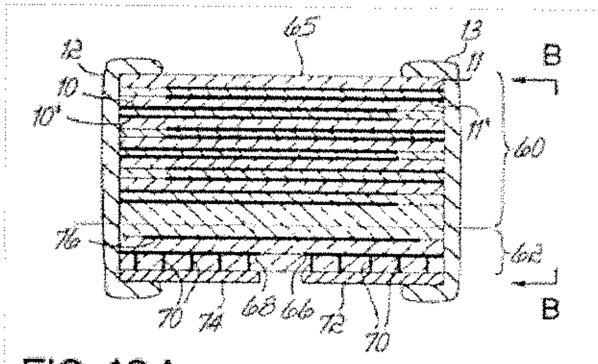


FIG. 10A

The parties seek construction of numerous limitations contained in the patent's claims. The following chart lists the disputed terms as well as the parties' positions on proposed construction.

| # | TERM | PRESIDIO'S PROPOSED CONSTRUCTION | ATC'S PROPOSED CONSTRUCTION |
|---|---|---|---|
| 1 | Substantially Monolithic Dielectric Body | A largely, but not necessarily wholly one-piece dielectric body | A dielectric body largely but not wholly without seams from the inclusion of conductive plates within the dielectric body |
| 2 | A Conductive First Contact Disposed Externally on the Dielectric Body and Electrically Connected to the First Plate | A conductive material arranged on an external surface portion of the substantially monolithic dielectric body having an electrical connection with the first plate | A conductive layer for attaching the capacitor (recited in the preamble) to an external conductor, the conductive layer being present on an external surface portion of the substantially monolithic dielectric body and touching the conductive first plate to establish electrical connection |
| 3 | A Conductive Second Contact Disposed Externally on the Dielectric Body and Electrically Connected to the Second Plate | A conductive material arranged on an external surface portion of the substantially monolithic dielectric body having an electrical connection with the second plate | A conductive layer for attaching the capacitor (recited in the preamble) to an external conductor, the conductive layer being present on an external surface portion of the substantially monolithic dielectric body and touching the conductive second plate to establish electrical connection |

| | | | |
|---|---|---|---|
| 4 | The Second Contact Being Located Sufficiently Close to the First Contact to Form a First Fringe-Effect Capacitance with the First Contact | Forming a capacitance between or proximate opposed ends of the first and second conductive contacts which affects the high frequency performance of the capacitor as a whole | An end of the first conductive contact and an end of the second conductive contact are positioned in an edge-to-edge relationship in such proximity as to form a determinable capacitance. |
| 5 | The Second Contact Being Located Sufficiently Close to the First Contact on the Second Side of the Dielectric Body to Form a Second Fringe-Effect Capacitance with the First Contact. | Forming a capacitance between or proximate opposed ends of the first and second conductive contacts on a second side of the substantially monolithic dielectric body which affects the high frequency performance of the capacitor as a whole | Another end of the first conductive contact and another end of the second conductive contact are present on the second side of the substantially monolithic dielectric body and are positioned in an edge-to-edge relationship in such proximity as to form a determinable capacitance. |
| 6 | The dielectric body has a hexahedron shape | The dielectric body has six major surfaces | The substantially monolithic dielectric body has six sides. |

## LEGAL STANDARD

In construing claims, the Court must look first to the language of the claims themselves. Middleton, Inc. v. Minnesota Mining & Mfg. Co., 311 F.3d 1384, 1387 (Fed. Cir. 2002). To that end, "the words of a claim 'are generally given their ordinary and customary meaning.'" Phillips v. AWH Corp., 415 F.3d 1303, 1312 (Fed. Cir. 2005). The inquiry into how a person of ordinary skill in the art understands a claim term provides an objective baseline from which to begin claim interpretation." Id. More specifically, "the ordinary and customary meaning of a claim term is the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention, as of the effective date f the patent application." Id. at 1313.

The specification is "'always highly relevant to the claim construction analysis. Usually, it is dispositive; it is the single best guide to the meaning of a disputed term.'" Phillips, 415 F.3d at 1315 (quoting Vitronics Corp. v. Conceptronic, Inc., 90 F.3d 1576, 1582 (Fed. Cir. 1996); accord Yoon Ja Kim v. Conagra Foods, Inc., 465 F.3d 1312, 1318 (Fed. Cir. 2006). Phillips invited courts "to rely heavily on the written description [in the specification] for guidance as to the meaning of the claims." 415 F.3d at 1317. For example, the specification may show that the inventor assigned a meaning to a claim term that differs from the claim's ordinary meaning, and, in that case, "the inventor's lexicography governs." Id. at 1316; accord Anderson Corp. v. Fiber Composites, LLC, 474 F.3d 1361

(Fed. Cir. 2007).

Under Federal Circuit precedent, a patentee's choice of embodiments can shed light on the intended scope of the claim, but a patent claim term is not limited merely because the embodiments in the specification all contain a particular feature. On the other hand, a construction that excludes a preferred embodiment is rarely, if ever, correct. C.R. Bard, Inc. v. United States Surgical Corp., 388 F.3d 858, 865 (Fed Cir. 2004) (internal citations and quotations omitted). The decision whether to limit a claim to the embodiments in the specification "depends in each case on the specificity of the description of the invention and on the prosecution history." Cultor Corp. v. A.E. Staley Mfg. Co., 224 F.3d 1328, 1331 (Fed Cir. 2000). The mere fact that a specification discloses a single embodiment is not enough. Liebel-Flarsheim Co. v. Medrad, 358 F.3d 898, 907 (Fed. Cir. 2004).

The court should rely on extrinsic evidence "[o]nly if a disputed claim term remains ambiguous after analysis of the intrinsic evidence." Pickholtz v. Rainbow Technologies, Inc., 284 F.3d 1365, 1372-73 (Fed. Cir. 2002). Extrinsic evidence is defined as "'all evidence external to the patent and prosecution history, including expert and inventor testimony, dictionaries, and learned treatises.'" Phillips, 415 F.3d at 1317 (quoting Markman v. Westview Instruments, Inc., 52 F.3d 967, 980 (Fed Cir. 1995), aff'd 517 U.S. 370 (1996)). Extrinsic evidence is separate from the patent, prepared for litigation purposes, and not necessarily reflective of the perspective of an ordinary person skilled in the art. Id. at 1318. A court must not use extrinsic evidence "to vary, contradict, expand, or limit the claim language from how it is defined, even implicitly, in the specification or [prosecution] history." Dow Chem. Co. v. Sumitomo Chem. Co., Ltd., 257 F.3d 1364, 1373 (Fed. Cir. 2001).

//

//

//

//

//

//

//

//

//

## CLAIM CONSTRUCTION

### I. Disputed Term 1: Substantially Monolithic Dielectric Body

| # | TERM | PRESIDIO'S PROPOSED CONSTRUCTION | ATC'S PROPOSED CONSTRUCTION |
|---|---|---|---|
| 1 | Substantially Monolithic Dielectric Body | A largely, but not necessarily wholly one-piece dielectric body | A dielectric body largely but not wholly without seams from the inclusion of conductive plates within the dielectric body |

i. Parties' Arguments

Presidio argues this term, "a substantially monolithic dielectric body" should be defined as "a largely, but not necessarily wholly, one piece dielectric body." Presidio relies on lay dictionary definitions for asserting "substantially" means "of ample or considerable amount" and "monolithic" means "consisting of one piece." Presidio explains that this definition captures the idea that the capacitor is not wholly a monolithic dielectric body because conductive structures may be placed on an external surface of the dielectric body, or inside the dielectric body. In support they cite portions of the patent specification which state that a dielectirc body "includes a series of conductive plates arranged in a substantially parallel and opposed configuration in one region of the body" and that "conductive structures may be one or more conductive plates positioned inside the dielectric body . . . . [Or] the conductive structures may be placed either on an external surface of the dielectric body, or inside the dielectric body . . . ." (the '356 patent, at col. 4, ln. 29-58.)

ATC suggests the claim language, "a substantial monolithic dielectric body," is indefinite or, alternatively, ought to be construed to mean "a dielectric body largely but not wholly without seams from the inclusion of plates within the dielectric body." At the claim construction hearing, ATC presented the testimony of Dr. Joseph P. Dougherty, who explained that a monolithic capacitor is formed by "sintering" (i.e. fusing) together multiple conductive and dielectric layers into a single block and then dipping that structure into a conductive liquid to form conductive contacts. Dr. Dougherty stated that, in his experience, there are no degrees of monolithicness; rather, a capacitor is either monolithic or it is not. As for the term, "substantially monolithic dielectric body," Dr. Dougherty said the term would mean nothing to a skilled artisan. However, in Dr. Doughtery's Rule 4.2 statement,

Case 3:08-cv-00335-IEG-NLS Document 24 Filed 07/14/2008 Page 7 of 16

he suggests the Court adopt the alternative construction put forth by ATC, explaining that the sintering of conductive plates forms the "seams" mentioned in ATC's construction and it is these seams which makes the dielectric body not entirely (i.e. only substantially) monolithic. ATC says the concept of seams is understood by skilled artisans based on its use in another Presidio patent to define the meaning of an "essentially" monolithic structure. (ATC's Opening Brief at 12, citing Presidio's U.S. Patent NO. 6,661,639 from a different patent family which states that "[t]he resulting capacitor is a plated, essentially monolithic structure . . . . By essentially we refer to the presence of the internal metallizations that create a partial boundry or seam within the structure . . . .").

ii. Analysis

As an initial matter, the Court declines to address ATC's indefiniteness argument at this point with respect to this and other disputed terms and concludes such analysis would be more appropriate at the summary judgment stage. See Kowalski v. Ocean Duek Corp., 2007 WL 4104259, *3 (D. Hawai'i, November 19, 2007); Intergraph Hardware Technologies Co. v. Toshiba Corp., 508 F.Supp.2d 752, 773 n.3 (N.D. Cal. August 2, 2007); Lisle Corp. v. A.J. Mfg. Co., 289 F.Supp.2d 1048, 1050 (N.D. Ill. 2003) (noting that in the vast majority of cases, claim indefinitness is decided in connection with a summary judgment motion); STX Inc. v. Brine, Inc., 37 F.Supp.2d 740, 754 (D.Md. 1999) (stating that "it would be error to collapse claim construction . . . into a statutory indefiniteness analysis.").

The term "substantially monolithic dielectric body" is not defined in the '356 patent and the Court finds the term remains ambiguous even after examination of specifications, embodiments, and other instrinsic evidence. Accordingly, the Court finds the use of extrinsic evidence appropriate in construing this disputed phrase.

The Court finds some guidance on how to interpret the disputed term by referencing the use of the term "monolithic" as used to characterize an entire multilayer capacitor structure. For instance, in the'356 patent section titled "Background of the Invention," the concept of monolithic ceramic structure is discussed. ('356 patent, col. 1, 2.) This discussion comes in the context of describing prior art, a structure shown in figure 2A, termed a "multilayer ceramic capacitor." The specification explains that such a structure is formed by stacking layers of a powdered ceramic dielectric material and holding those layers together by applying an organic binder. After all layers have been stacked and conductive structures are printed on top of various layers to form the desired capacitance, the layers are compressed and diced into capacitors. At this point, the capacitors are heated to drive off the organic binder and fuse the powdered ceramic material into a "monolithic" structure. (Id., at col. 2, ln 12.) Later, in the summary of invention for the '356 patent, it is explained that the disclosed embodiments have "substantially monolithic dielectric body" formed from a plurality of ceramic tape layers laminated together and fired to form a sintered or fused monolithic ceramic structure. (Id., at col. 4, ln 61-65.) The McGraw Hill Dictionary of Scientific and Technical Terms similarly defines a monolithic ceramic capacitor as a "capacitor that consists of thin dielectric layers interleaved with staggered metal-film electrodes . . . compressed and sintered to form a solid monolithic block."

The use of the term "monolithic" in both the background section of the '356 patent and this technical dictionary suggests that, contrary to Presidio's assertion, an experienced artisan would not discount a dielectric body's "monolithicness" based on the presence of conductive plates inside the dielectric. Further, as ATC persuasively argues, the addition of conductive contacts to the exterior of the dielectric body would have no impact on whether the dielectric body itself is monolithic.

Dr. Dougherty testified that the degraded "monolithicness" of the dielectric body referenced by the disputed claim term would be understood by a capacitor designer to refer to seams caused by metal plates protruding out of the dielectric body. Presido's briefing, while stating the extrinsic evidence in general is less reliable than intrinsic evidence, gives no reason to discount Dr. Doughtery's assertion. Presidio's reliance on a non-technical dictionary definition to refute Dr. Doughtery, a learned artisan, is unpersuasive.

iii. Construction

Based on the forgoing, the Court construes the term "substantially monolithic dielectric body" as "a dielectric body largely but not wholly without seams from the inclusion of plates within the dielectric body."

//

//

//

**II. Disputed Term 2: A Conductive First Contact Disposed Externally on the Dielectric Body and Electrically Connected to the First Plate**

| # | TERM | PRESIDIO'S PROPOSED CONSTRUCTION | ATC'S PROPOSED CONSTRUCTION |
|---|---|---|---|
| 2 | A Conductive First Contact Disposed Externally on the Dielectric Body and Electrically Connected to the First Plate | A conductive material arranged on an external surface portion of the substantially monolithic dielectric body having an electrical connection with the first plate | A conductive layer for attaching the capacitor (recited in the preamble) to an external conductor, the conductive layer being present on an external surface portion of the substantially monolithic dielectric body and touching the conductive first plate to establish electrical connection |

The major differences between the parties' construction involves alternative construction for four separate sub-phrases within the disputed term:

**i. the "conductive first contact" is conductive "material" versus a "conductive "layer."**

a. Parties' Arguments

Presidio argues the conductive first contact should be construed as a conductive "material." In support, Presidio cites the summary of invention, which teaches that multiple conductive structures may be formed on the exterior of the capacitor. (See '356 patent, col. 4:52-56 ("conductive structures may be one or more conductive plates positioned inside the dielectric body [or] placed [] on an external surface of the dielectric body . . ."). By envisioning the use of multiple conductive structures, Presidio argues this specification makes clear that the first contact is not necessarily of uniform composition, i.e., a single layer. Precidio asserts that attempting to define the term "contact" to a single structure of uniform construction is an attempt to define the term more precisely than is warranted by the claim.

ATC argues "conductive first contact" should be construed as a "a conductive layer" because the specification does not disclose an instance of a multi-layer contact. ATC cites 37 C.F.R. § 1.84(h)(3) which requires that a "cross section set out . . . all of the materials as they are shown in the view from which the cross section is taken." And which states that "parts in cross section must show proper material(s) by hatching with regularly spaced parallel oblique strokes . . . ." ATC also notes that in every instance in which a "contact" is shown in a cross-section, the contact is shown as having a uniform composition, i.e., a uniform cross hatching. ATC argues this construction is consistent with the only description in the specification of how contacts are created, which is "dipping" the device in a conductive material ('356 patent, col. 2, lines 13-16). In the alternative, ATC suggests modifying Presidio's construction so that a contact would be defined as "a single conductive material of uniform composition."

b. Analysis

The summary of invention teaches that conductive structures used in the invention may be one or more conductive plates and explains that such structures may be placed on an external surface of the dielectric body. (col 4, 52-56). The language of the specification includes no limitation that such structures be comprised of only a single layer. Nor does the Court construe the language of 37 C.F.R. 1.84(h)(3) to require that structures hatched in the same manner be of uniform construction. All the regulation directs is that a particular cross-hatch be applied to demonstrate that a particular part or structure exists, not that it must be of "uniform construction." Finally, ATC's reference to the description of how contacts are created is inapposite, as the dipping procedure described therein references prior art. (See '356 patent, col. 2., lines 13-16.) Accordingly, the Court declines to limit the claim language as suggested by ATC and construes "the conductive first contact" as "a conductive material." Because the claim language may be construed by reference to the specification, extrinsic evidence is not appropriate in construing this disputed phrase.

**ii. the contact must be attachable to an external conductor**

a. Parties Argument

Relying on a alleged admission by Presidio's expert, Dr. Godshalk, ATC asserts the contact would have to be attachable to a conductor to be a useful device.

b. Analysis

There is no language in the claim term that speaks to any relationship between the conductive first material and an external conductor. Dr. Goldshalk did testify that to make the capacitor a useful device, a conductive structure of the capacitor must attach to an external conductor. However, Dr. Godshalk did not testify that the claim language requires that the conductive first material be attachable to an external conductor. Accordingly, the Court rejects ATC's proposed language.

Case 3:08-cv-00335-IEG-NLS Document 24 Filed 07/14/2008 Page 11 of 16

**iii. "disposed externally on" means "present on" versus "arranged on"**

a. Parties Argument

Another difference between the parties' construction of the claim is on the issue of whether "disposed eternally on" (as between the conductive first contact, i.e. 12 in the figure 10A above, and the dielectric body) should be construed as "present on," meaning physically touching, or "arranged on," which would cover an indirect form of connection. ATC notes that the Federal Circuit has stated that "on" means "in physical contact with" in the case Senmed, Inc. v. Richard-Allan Med. Indus., Inc., 888 F.2d 815 (Fed. Cir. 1989) disapproved on other grounds by Cardinal Chem. Co. v. Morton Int'l, Inc., 508 U.S. 83 (1993). ATC also cites the Federal Circuit's decision which interpreted the phrase "mounted on" denotes a form of attachment, not simply an electrical connection." Asyst Tech. Inc. v. Emtrak, 402 F.3d 1188, 1194 (Fed. Cir. 2005).

Presidio, citing a lay dictionary definition, contends that the definition of "disposed on," is "arranged on." Presidio claims Senmed is inapposite since the court based its decision on evidence that during prosecution of the patent-in-suit, the prosecuting attorney took inconsistent positions. Presumably, argues Presidio, had no prosecution history estoppel been present, the term "on" would have been appropriately defined as not requiring physical contact. Similarly, Presidio argues that the citation to Asyst Tech is also unavailing because the claim term in dispute there was "mounted on" and the context of its use in the specifications made it clear that it was used in those instances to mean securely fixed to objects. Here, the disputed term is "disposed on" which has a broader connotation.

b. Analysis

ATC's argument that the Federal Circuit decisions in Senmed and Asyst require "on" be construed as "in physical contact with" is unpersuasive. No language in the specification implies such a requirement. While the embodiments consistently show the contact physically touching the dielectric body, it is improper to rely solely on these embodiments to impose limitations on the claim language. See C.R. Bard, 388 F.3d at 865 (""Under our precedent, a patentee's choice of embodiments can shed light on the intended scope of the claim, but a patent claim term is not limited merely because the embodiments in the specification all contain a particular feature."). Accordingly, the Court construes "disposed externally on" consistent with definition set forth by Presidio as "arranged on."

**iv. "electrically connected to the first plate" means "having an electrical connection with the first plate" versus "touching the conductive first plate to establish an electrical connection"**

a. Parties Argument

ATC argues physical touching is required between the contact and the first plate because that is the way that the contact and plate are repeatedly and consistently referenced in the specification and figures.

b. Analysis

Similar to the Court's conclusion above, while several of the embodiments describe contacts forming a common connection point for each plate extending to that side. (See e.g., '356 patent, col 6, line 25-28; col. 9, line 46-47), such embodiments do not compel a limitation of the claim language. See C.R. Bard, 388 F.3d at 865. The language simply does not suggest such a requirement Accordingly, the Court construes "electrically connected to the first plate" as "having an electrical connection with the first plate."

**v. Construction**

Based on the forgoing, the Court construes the term "a conductive first contact disposed externally on the dielectric body and electrically connected to the first plate" as "a conductive material arranged on an external surface portion of the substantially monolithic dielectric body and having an electrical connection with the first plate."

**III. A Conductive Second Contact Disposed externally on the Dielectric Body and Electrically Connected to the Second Plate**

| # | TERM | PRESIDIO'S PROPOSED CONSTRUCTION | ATC'S PROPOSED CONSTRUCTION |
|---|---|---|---|
| 3 | A Conductive Second Contact Disposed Externally on the Dielectric Body and Electrically Connected to the Second Plate | A conductive material arranged on an external surface portion of the substantially monolithic dielectric body having an electrical connection with the second plate | A conductive layer for attaching the capacitor (recited in the preamble) to an external conductor, the conductive layer being present on an external surface portion of the substantially monolithic dielectric body and touching the conductive second plate to establish electrical connection |

As the parties conceded, this claim term should be defined consistent with the previous

Case 3:08-cv-00335-IEG-NLS Document 24 Filed 07/14/2008 Page 13 of 16

term. Accordingly, consistent with the reasoning and discussion above, the Court construes the term "a conductive second contact disposed externally on the dielectric body and electrically connected to the second plate" as "a conductive material arranged on an external surface portion of the substantially monolithic dielectric body and having an electrical connection with the second plate."

## IV. The Second Contact Being Located Sufficiently Close to the First Contact to Form a First Fringe-Effect Capacitance with the First Contact

| # | TERM | PRESIDIO'S PROPOSED CONSTRUCTION | ATC'S PROPOSED CONSTRUCTION |
|---|---|---|---|
| 4 | The Second Contact Being Located Sufficiently Close to the First Contact to Form a First Fringe-Effect Capacitance with the First Contact | Forming a capacitance between or proximate opposed ends of the first and second conductive contacts which affects the high frequency performance of the capacitor as a whole | An end of the first conductive contact and an end of the second conductive contact are positioned in an edge-to-edge relationship in such proximity as to form a determinable capacitance. |

### i. Parties' Arguments

Presidio asserts the claim term should be defined as "forming a capacitance between or proximate opposed ends of the first and second conductive contacts which affects the high frequency performance of the capacitor as a whole." Presidio explains that the '356 patent solves the high frequency problems of earlier capacitors and cites instances in the specification where the '356 patent mentions that certain fringe capacitance may affect the very high frequency performance of the device. (See e.g., '356 patent, col. 4, ln. 55, 60.)

ATC asserts the disputed term should be interpreted as "an end of the first conductive contact and an end of the second conductive contact are positioned in an edge-to-edge relationship in such proximity as to form a determinable capacitance." ATC argues its construction is consistent with the plain meaning of the claim and argues Presidio's construction should be rejected since claim 1 does not recite any limitations or effects on high-frequency performance. At the claim construction hearing, Dr. Dougherty testified that the'356 patent does not explain how forming a fringe-effect capacitance would have a measurable effect on the high frequency performance of the capacitor. Further, ATC argues this is an improper functional definition since it is impermissible to define an invention by "what it does rather than what it is" when no parameters are provided. Halliburton Energy Services, Inc. v. M-I LLC, 514 F.3d 1244, 1255-1256 (Fed. Cir. 2008).

ii. Analysis

The effect on high frequency performance is not mentioned in claim 1 and nowhere in the specification is the effect on high frequency performance explained. There is simply no justification for introducing the language advanced by Presidio into the construction of the disputed claim term.

iii. Construction

The Court construes the term "the second contact being located sufficiently close to the first contact to form a first fringe-effect capacitance with the first contact" as "an end of the first conductive contact and an end of the second conductive contact are positioned in an edge-to-edge relationship in such proximity as to form a determinable capacitance."

**V. The Second Contact Being Located Sufficiently Close to the First Contact on the Second Side of the Dielectric Body to Form a Second Fringe-Effect capacitance with the First Contact**

| # | TERM | PRESIDIO'S PROPOSED CONSTRUCTION | ATC'S PROPOSED CONSTRUCTION |
|---|---|---|---|
| 5 | The Second Contact Being Located Sufficiently Close to the First Contact on the Second Side of the Dielectric Body to Form a Second Fringe-Effect capacitance with the First Contact. | Forming a capacitance between or proximate opposed ends of the first and second conductive contacts on a second side of the substantially monolithic dielectric body which affects the high frequency performance of the capacitor as a whole | Another end of the first conductive contact and another end of the second conductive contact are present on the second side of the substantially monolithic dielectric body and are positioned in an edge-to-edge relationship in such proximity as to form a determinable capacitance. |

As the parties conceded, this claim term should be defined consistent with the previous term. Accordingly, consistent with the reasoning and discussion above Court construes "the second contact being located sufficiently close to the first contact on the second side of the dielectric body to form a second fringe-effect capacitance with the first contact" as "another end of the first conductive contact and another end of the second conductive contact are present on the second side of the substantially monolithic dielectric body and are positioned in an edge-to-edge relationship in such proximity as to form a determinable capacitance."

## VI. The dielectric body has a hexahedron shape

| # | TERM | PRESIDIO'S PROPOSED CONSTRUCTION | ATC'S PROPOSED CONSTRUCTION |
|---|---|---|---|
| 6 | The dielectric body has a hexahedron shape | The dielectric body has six major surfaces | The substantially monolithic dielectric body has six sides. |

### i. Parties' Argument

Presidio proposes the term be defined as "the dielectric body has six major surfaces." Presidio argues that structures that are not hexahedrons were contemplated by the claim term, otherwise the claim language would not include the term "shape." Presidio adds that the majority of the figures in the '356 patent have channels and other features that define more than six sides. (See e.g., Figs. 9a, 10A, 11A, 12A, 20A). Presidio argues it would be impermissible to adopt a construction that would exclude these embodiments.

ATC proposes the following construction: "the substantially monolithic dielectric body has six sides." ATC says hexahedron is a mathematical term which is precise, namely, a three-dimensional object with 6 sides or faces. As such, there should be no room for a definition that calls for six major surfaces with the option for other "minor" surfaces or additional major surfaces. ATC notes that Dr. Godshalk (Plaintiff's expert) admitted that the '356 patent does not disclose an objective standard for determining the difference between "major" and "minor" surfaces.

### ii. Analysis

Where the '356 patent does not teach how to distinguish between a "major" and "minor" surface, the disputed term's use of the term "shape" does not expand the definition of hexahedron to include all objects with six major surfaces. The two dimensional views of dielectric bodies in the embodiments cited by Presidio do not establish an expansion of the claim language. Accordingly, Presidio's proposed construction is rejected.

### iii. Construction

The Court construes the disputed term "the dielectric body has a hexahedron shape" as "the substantially monolithic dielectric body has six sides."

Case 3:08-cv-00335-IEG-NLS Document 24 Filed 07/14/2008 Page 16 of 16

## CONCLUSION

Having reviewed the amended joint claim chart and the patents-in-suit, the Court **CONSTRUES** the disputed terms as follows:

I. **Substantially Monolithic Dielectric Body**: a dielectric body largely but not wholly without seams from the inclusion of plates within the dielectric body.

II. **A Conductive First contact Disposed Externally on the Dielectric Body and Electrically Connected to the First Plate:** a conductive material arranged on an external surface portion of the substantially monolithic dielectric body and having an electrical connection with the first plate.

III. **A Conductive Second Contact Disposed Externally on the Dielectric Body and Electrically Connected to the Second Plate:** a conductive material arranged on an external surface portion of the substantially monolithic dielectric body and having an electrical connection with the second plate.

IV. **The Second Contact Being Located Sufficiently Close to the First Contact to Form a First Fringe-Effect Capacitance with the First Contact:** an end of the first conductive contact and an end of the second conductive contact are positioned in an edge-to-edge relationship in such proximity as to form a determinable capacitance.

V. **The Second Contact Being Located Sufficiently Close to the First Contact on the Second Side of the Dielectric Body to Form a Second Fringe-Effect Capacitance with the First Contact**: another end of the first conductive contact and another end of the second conductive contact are present on the second side of the substantially monolithic dielectric body and are positioned in an edge-to-edge relationship in such proximity as to form a determinable capacitance.

VI. **the dielectric body has a hexahedron shape**: the substantially monolithic dielectric body has six sides.

**IT IS SO ORDERED.**

**DATED: June 11, 2008**

[signature]

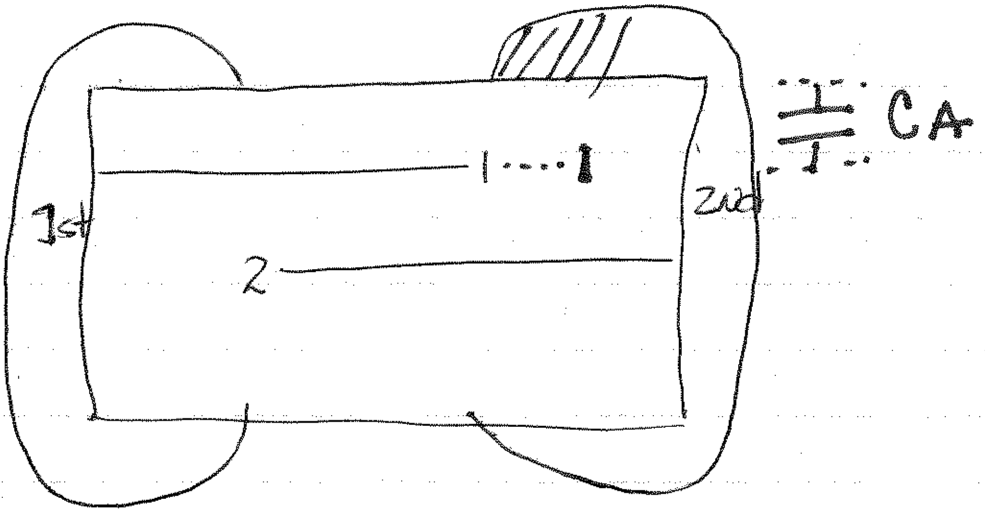
**IRMA E. GONZALEZ, Chief Judge**

**United States District Court**

$$C = \frac{KA}{d}$$

assume K is dielectric constant
A is plate area
measurements are dc
d is distance

EXHIBIT
Ex. 7
Ewell 8-1-08



1, 2 – conductive plates
1st – conductive first contact
2nd – conductive second contact

EXHIBIT
Ex. 8
Ewell 8-1-08

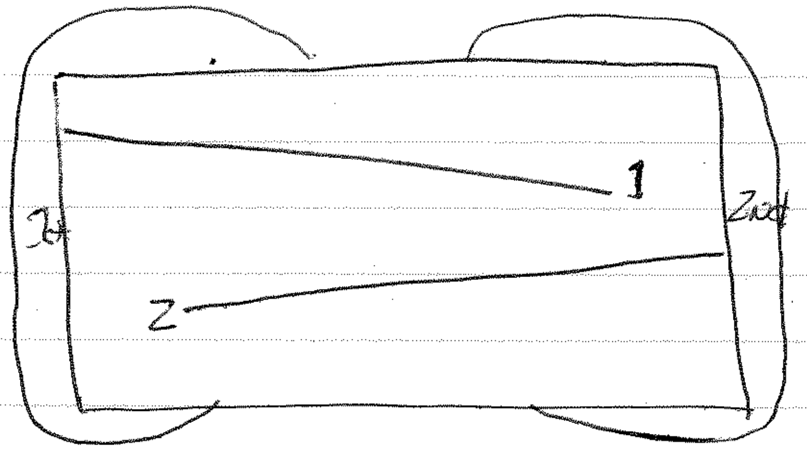


EXHIBIT
Ex. 9
Ewell 8-1-08

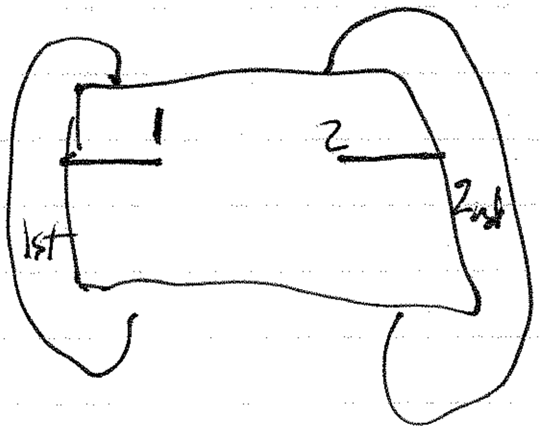


EXHIBIT
Ex. 10
Ewell 8-1-08